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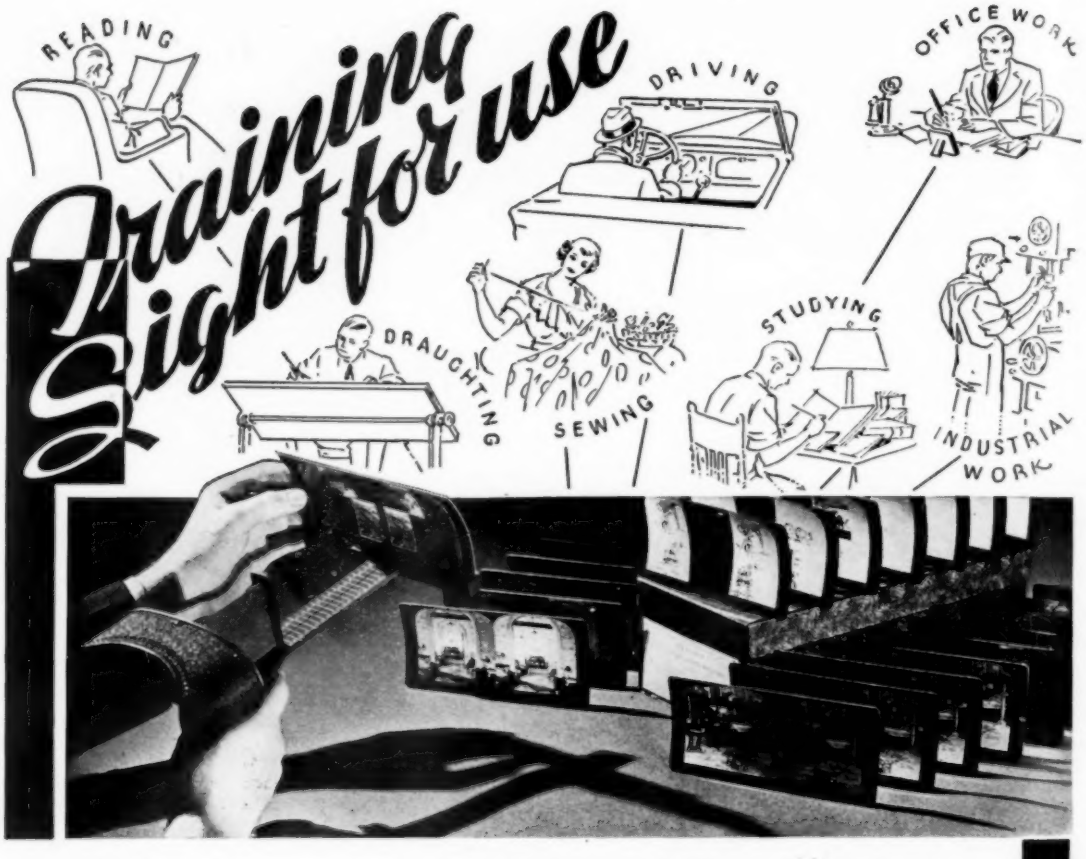

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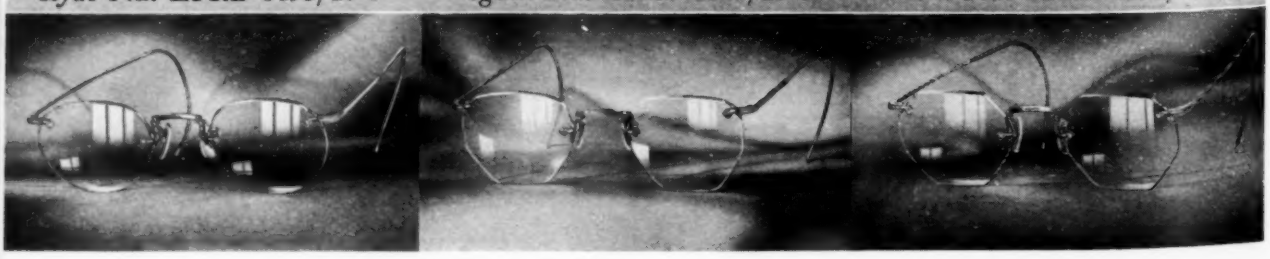

American

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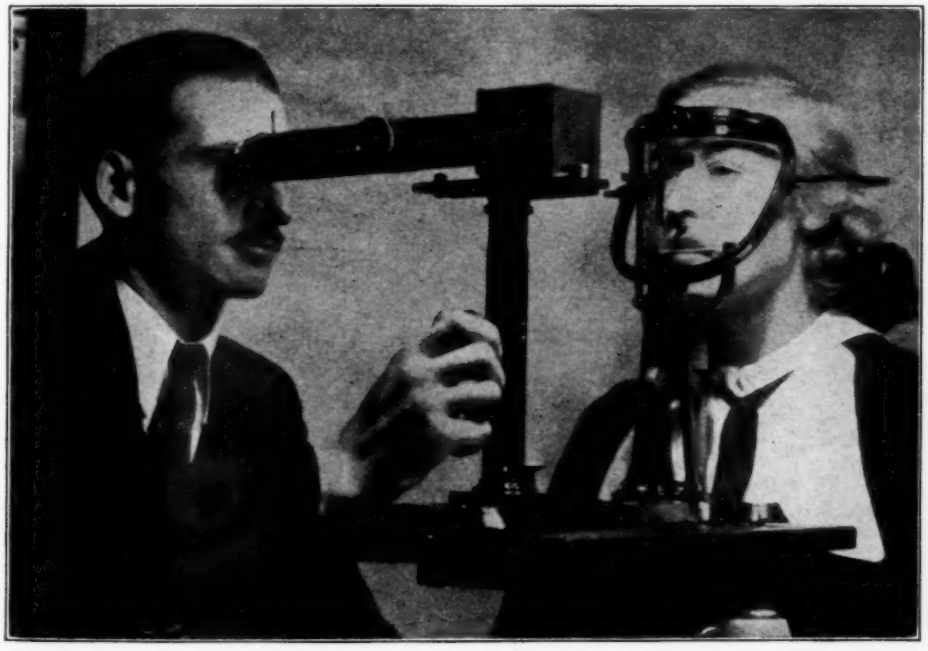
THE TROPOMETER*

G. L. Du Plessis, Opt.D.
Minneapolis, Minn.

In 1894, George T. Stevens introduced a new instrument at a meeting of the American Medical Association, held in Baltimore. This instrument, he called the "tropometer," an instrument to measure muscles. It is occasionally seen on the shelves of optical jobbers, accumulating dust and every year at inventory time, exciting wondrous comment at what it was used for, if ever used.

The tropometer (see figure) is designed to measure the excursions of the eye in its principal meridians. This had been done before with



*An abridgment of the material presented before the Minnesota Academy of Optometry at Minneapolis, March 29, 1936.

the perimeter, but the method had been found wanting. The perimeter is subjective and the determination of the excursion of the eye depends on the patient's fixation, this in turn being limited by the contour of the orbit and nose, and the extent of the visual acuity. The tropometer is entirely objective in its use.

It consists of (a) a head rest and stirrup onto which is clamped a piece of wood that the patient bites to steady the head. The angle of the stirrup is adjustable to conform to various angles of dentures. Two buttons are adjustable up and down and so arranged as to determine the primary position or plane of the patient's face.

The objective (b) is movable forward and back on the base of the instrument. The distances from the eye are indicated on a scale in centimeters. This objective can be elevated or lowered and placed directly in front of either eye. The fixation is a spot on the glass cover of the objective. Behind this is a mirror at a 45° angle, then an ordinary focussing telescope with adjustable eyepiece. Inside the eyepiece is a small transparent scale made photographically, this scale bearing figures (tangeant scale) indicating the rotations of the eyes in degrees. It is a tangeant scale showing on a plane surface the deviation of a section of sphere. One-half of this scale shows excursion upward, the other half, downward. The scale can be rotated 90° to show lateral excursions in the same way.

In use, a wooden strip, later discarded, is placed in the stirrup, the patient's head is placed in the rest and he seizes the wooden strip between his teeth. The stirrup is adjusted so that the two buttons touch the glabella and the upper lip just under the nose. The two buttons being in a vertical plane, the patient's facial plane is now vertical. The head clamp is brought down and adjusted to touch firmly the occipital protuberance, thus holding the head in the original position.

The eyepiece is focussed to the scale for the observer's ametropia. The objective is set before one eye, moved forward or back until the image of the cornea occupies the whole space between the heavy o° lines of the scale. The telescope is focussed to give a sharp image of the corneal limbus. The observer's hand is placed on the patient's head to detect any unconscious movement of the patient. A finger may be needed to lift the upper lid to frame the cornea on the scale in vertical measurement.

With everything in position, the patient is directed to look to the right as far as possible. The corneal margin, formerly at the zero line, is seen to move from zero to 45°. In other words, the right eye can turn temporally 45°. The patient is then instructed to look to the left as far as possible. The excursion is noted.

The scale is then turned 90° and recentered if necessary. The patient is then instructed to look up as far as possible and down as far as possible. As the telescope reverses the image the eye appears to move down and up respectively. A little practice makes these measurements easy to

secure. We then have four findings for each eye which could be written thus:

	35	Up	40	
O. D.	50	Down	40	O. S.
	50	Nasal	45	
	45	Temporal	50	

What measurements are to be expected in the normal case:

Up	35°
Down	45 to 50°
Nasal	50°
Temporal	45°

The vertical measurements are most apt to vary. Minor variations in the lateral direction may be suggestive of phorias, but this theory requires more investigation. Large variations in the lateral direction are found, according to Stevens, only in gross muscular deviations or paralysis.

However, variations in the vertical movements are commonly found and the amount may be large. There may be a marked difference between the two eyes or the up version may be greater than the down version. equally in both eyes. We now come to the value of these findings. But before making claims of value it is necessary to elucidate certain relations between the anatomy of the head and orbit, and ocular physiology.

The transverse diameter of the skull is measured at its widest part behind the ear. The longitudinal is measured from the glabella to the occipital protuberance. Craniologists have classified skulls generally into three groups:

The Dolichocephalic, or long skull, is one whose transverse diameter is less than 75% of the longitudinal.

The Mesocephalic, or medium skull, is one whose transverse diameter is between 75 and 85% of the longitudinal.

The Brachycephalic, or broad skull, is one whose transverse diameter is more than 85% of the longitudinal diameter.

In the average person the plane of vision is at right angle to the facial plane as measured in the relation of the glabella to the superior maxillary ridge and the tip of the chin. Viewed from the side the dolichocephalic skull is accompanied by a convex type of face, that is: a receding forehead and chin, a prominent nose. The mesocephalic usually has a straight facial plane; the brachycephalic, a concave face as shown by a prominent forehead and chin.

Due to the anatomical structure of the orbits of these various skulls, the vertical rotations will vary.

It has been found that with a vertical facial plane, the static direction of regard is near the horizon, that in such a case the average up and down excursion totals 83° with about 50° below the horizontal plane

and 33° above. With such movements in the principal meridians a horoptor is formed without torsional adjustment of the eyes, but if an upward rotation much in excess of that given is present, torsional adjustments are needed even in the primary vertical meridians.

It has also been found that the axis of the orbit varies with the type of skull, the axis of the dolichocephalic being directed downward, the brachycephalic upward; and that this direction of the orbital axis corresponds with the direction of regard as suggested by tropometer measurements. We thus see that if the vertical measurement of a pair of eyes is 45° upward and 35° downward the static plane of vision is elevated 15° above the horizon: a condition of anaphoria, probably anatomical. This will be confirmed by a dolichocephalic skull, especially if the facial contour is positive or convex.

As the depression of the line of regard to the horizon requires dynamic functioning, such a case may find it more convenient to tilt the head forward or even assume a stooped posture which in time becomes habitual. Reading, for instance, requires a depression of some 30° below the primary position of the normal horoptor; if the static position of the line of regard is already elevated 10°, the depression of the line of regard to reading position may then be expressed as 40° in terms of nervous energy. If this is uncomfortable, part of the work is performed by the head and the muscles of the neck.

We thus see that a knowledge of the excursing ability of the eye, especially up and down as measured by the tropometer, will give clues to the solution of unrelated complaints such as orbital pain and pain in the back of the neck, etc.

Anaphoria and cataphoria must be more common than ordinarily supposed. Supra-duction as measured by the rotary prisms may be indicative, but it is the writer's belief that it is only a confirming finding in extreme cases, because in such measurement, quality of fusion is an important factor and muscular measurements involving fusion are not dependable in determining mechanical pull.

Anaphoria is troublesome in close occupations and reading. Stevens goes so far as to suggest that by causing a tilting forward of the head, the respiratory passages are narrowed, and thus anaphoria may predispose to tuberculosis. Anaphoria is troublesome in reading not only because of the stress to the inferiors, but also because of the increased positive torsion and the resultant stress on the inferior obliques. It would seem that those cases must have an esophoria unrelated to the ametropia. In fact, we should suspect a cataphoria or, and especially, an anaphoria in cases where the esophoria is not predicated by the error or eliminated by its correction.

Esophoria not predicated or eliminated

- Habitual positive declination
- Excess supraduction
- Stooped posture
- Convex face
- Long skull
- Pain in back and eyes in reading

→ Point to anaphoria

- Habitual negative declination or none
- Infraduction excess
- Head thrown back
- Concave or straight face
- Medium or broad skull
- Pain in neck

→ Point to cataphoria

→ Differentiated by tropometer test

A marked elevation of one eye over the other as evidenced by the tropometer is suggestive of hyperphoria. The elevation may be exaggerated in both eyes, but more so in one eye than the other.

In attempting to relieve an anaphoria, the prisms base down before each eye may need to be unequal to conform to the hyperphoria. The correction of hyperphoria by prisms is dependent on phorometer tests which will give no indication of the anaphoria unless it is extreme.

In a consideration of this subject, we must bear in mind that as the plane of rotation is changed, the relative pull of each muscle varies. Maximum turning outward, for instance, is only possible in a natural horizontal plane, because in that plane the vertical recti give the minimum of interference.

To quote Stevens: "If the deviation of esotropia is often associated with hypertropia, even more pronounced is the association of exotropia with the deviation in the vertical direction. It is, indeed, rare to find the images in the crossed diplopia of divergent strabismus in the same plane, and the degree of hypertropia is usually considerable. As in convergent strabismus there is often a somewhat increased medial rotation of both eyes, so there is with divergent squint frequently a moderate restriction of the nasal with a somewhat increased temporal rotation. The extent of the restriction of the nasal and of the increase of the temporal rotations do not, however, bear any proportionate relation to the extent of divergence, and the extent of inward rotation is about equal for the two eyes. This rule does not hold good when with a considerable degree of hypertropia one eye is adjusted nearly in what, for convenience, may be called the normal plane. In that case the eye which is adjusted for a plane neither too high nor too low will have a greater freedom of rotation in the nasal direction than its fellow, which will be held back by the action of the vertically acting muscles."

Stevens in his book, Motor Apparatus of the Eye, offers a table of two hundred *consecutive* cases showing that hypertropia is the principal element of squint in 24.5% of cases an important element in 50% and present in nearly all other cases. In many cases he has directed surgical intervention solely to the vertical muscles with good results.

As to the causes of strabismus, he denies that accommodation is as important a factor as preconized by Donders, and that hypertropia anatomically or physiologically caused by declinations (astigmatism) as a cause has been underestimated.

He cites cases of spheres before hyperopes having no effect, whereas prisms base up or down as might be required eliminated convergent squint. One possible explanation for what success is had with plus spheres in unrelated cases may be that the patient soon finds a visual position producing through the spheres such a prism as will neutralize the hyperphoria. There must be more than a grain of truth to his theory when we recall many cases of squint, particularly moderately hyperopic convergent squints combined with a hypertropia. It is to be remembered that small hypertropias in squinters are difficult to detect and declinations almost impossible to determine, except objectively by using a dye stain on the cornea and watching the movement of this spot as the eye changes its position.

The tropometer is best used in conjunction with the clinoscope as designed by Stevens. As a substitute for the latter instrument, the phoropter can be used if it contains two white maddox rods marked in degrees plus or minus to indicate declinations and if the settings on the maddox rods are reasonably accurate. However, a fine sense of discrimination on the part of the patient is needed to differentiate less than five degrees declination, when the tests are made thus, or by any of the customary cyclophoric tests.

Till now, the tropometer has been represented as an instrument to measure versions of the eye for diagnostic purposes. It occurred to the writer that the instrument could also be used satisfactorily to determine the extent of deviation, both lateral and vertical. This is difficult to achieve subjectively as simultaneous binocular vision is usually absent and even when it is present projection is often false.

A few years ago the writer suggested an objective method for that purpose, the tropometer method while not quite as accurate is much more simple and is more accurate than the perimeter method.

The patient is placed in the head rest in the usual way. The pupil is focussed and the edge that we have selected for measurement is lined up on the scale at the zero mark by raising and swinging the objective. While this is being done the patient is forced to fixate with the habitually deviating eye, by the observer covering the good eye. When the adjustment is completed, the card is removed and fixation transferred to the good eye. The habitually squinting eye then deviates and its excursion is read in degrees on the scale.

The writer has tried this method only in concomittant squint. However, he sees no reason why it could not be used in all other forms of squint except paralytic. In total ophthalmoplegia no measurements are needed and in partial paralysis the tropometer can be used in its usual way.

This suggestion broadens the use of the tropometer to more than an experimental folly. The instrument was quite widely used at one time by advocates of the surgical treatment of squint. It has merits and as no substitute is available, until there is, it should form part of the armentatorium of the refractionist interested not only in effecting the cure of squint, but also in knowing why he succeeded.

Too many of the so-called cures of squint are the result of "stabs in the dark" giving the operator little credit and the optometric literature no information of use.

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A DISCUSSION OF SOME PRESENT METHODS OF CASE PROCEDURE AND THEIR INTERPRETATION*

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During the present period many practical thoughts and theories, and too many impractical ideas and techniques have emanated from the minds of optometric practitioners. Due credit should be given to all these men, whose prime purpose has been to make the profession of Optometry more effective for both the patients and the optometrists. Therefore, it is not the purpose of this article to detract from their work nor criticize it in any way, but in addition to presenting a form of case analysis, to also appeal to the practitioners that they should and must delve into the "why and wherefores" of their findings; debate and argue, look for fallacies and discrepancies in other men's opinions, for that is the only way any profession can advance. In other professions, theories are not accepted as facts until definite and convincing laboratory experiments with their consequent detailed "controls" prove a theory to be a fact, so why should the thinking in our profession be different? The fact that one man or one group of men say a certain finding should be 10 prism dioptors for instance, should not be taken for granted, ask yourself *why?*, ask these men *why?* And when a reason is given see if it is plausible.

Some present day groups have seemingly tried to place the human eye and its associated functions on a plane with a mechanical object, treating that eye as if it were a machine, expecting certain definite numbered values, any deviation of even a single unit being looked at as "something wrong." Anyone who has a slight understanding of the human body realizes that the eyes which are intimately associated with the nervous, muscular and vascular system of the human body, cannot be treated "robot-like." Any such methods which analyze by the above interpretations are impossible.

The modern optometrist, using a logical method of case analysis, should have and has, a good groundwork of physiological principles, muscular and neurological, not only of the eye, but also of the human body. Then, too, of course, refractive work entails a thorough under-

*Submitted for publication April 10, 1936.

standing of the principles of ocular testing, physiological and geometrical optics with a good knowledge of the nervous pathways involved.

The proper analysis of a case should begin after all the findings have been recorded. A discussion of some of the methods and findings will now follow.

We should first include a good and intensive history of the individual's complaints, complete in all detail. Inquiries into any general disturbance is important. All peculiarities of vision should be noted. The questions should be direct and to the point, yet not suggestive. Above all, record the answers. It is impossible to retain this by memory. It will prove to be immensely helpful in your diagnosis, and correlated with your refractive data you will get a great deal of satisfaction in knowing just why the patient has such symptoms.

Immediately after the history is taken and the confidence of the patient is gained, take the visual acuity without the old prescription and with it, if present. Record it, it is valuable. If one eye has better vision than the other we immediately know that most likely anisometropia or perhaps amblyopia exists. It is surprising how many men do not take the uncorrected visual acuity. (not recording it is just as great a mistake) and will prescribe a higher ametropia correction to the eye with the better vision, through faulty subjective technique, whereas if the visual acuity were recorded he would immediately guard himself against such error. Of course there may be certain exceptions, but we are dealing with the average case. In cases where the visual acuity is extremely poor we may use a pin-hole disc at this point in order to determine whether there will be difficulty in improving the visual acuity. Care should be taken here that the patient does not narrow his lid aperture and time should be taken so that an accurate result may be obtained.

We next advance to the external and ophthalmoscopic examination. This should be complete in every detail. Abnormalities should be closely looked for and if any are present, such should be recorded. Injection of all types should be noted. Opacities and lesions, if present, should be described fully for future reference and so the course of the disease noted. At this point, if intensely lowered acuity was present, ask yourself why, and start looking for the cause at this stage. Look for vascular system deficiencies which so often make themselves evident in the eye. We all know how invaluable we may be to the patient if we discover signs of a systemic condition he is not aware of and refer him for treatment to his physician. This again, is of benefit financially as better contacts are made. Such a minute examination should take a short time. If pathology is discovered, do not make the mistake of telling the patient immediately, and when you do, say it in such a way that he or she has no cause for alarm. Then for your own satisfaction and knowledge, when the patient leaves, think and reason out why such pathology should manifest itself in that particular locality, look it up

in your pathology text so that you may talk intelligently about it to your patient and to his or her physician. It is only with such spirit and ever-seeking attitude toward the "whys" (which implies more knowledge), that Optometry will continue to advance.

The next step in the procedure is Keratometry. The actual explanation of the technique is unnecessary, to go into as it is adequately and nicely treated by Ryer[1]. It would not be amiss to say here that the reading should be taken carefully, do not see with what speed you can measure the corneal curves but rather with what efficienecy it can be accomplished. Record the amount, axis, with or against the rule, and the dioptric value of the primary meridian. Incidentally, few practitioners "bother" to record the value of the primary meridian in diopters as indicated by the instrument, but its value is essential when we are dealing with anisometropic cases. It may tend to indicate whether the patient's ametropia is axial or refractive, thereby giving us an indication of the relative size of retinal images. For example let us take a case of: O. D. + 1.00 D. Sph., O. S. + 6.00 D. Sph. In this case the primary meridian of the right eye had a dioptric value of 42.00 D. The left eye, however, showed, in the primary meridian, a dioptric value of only 36.00 D. This error then is most likely refractive, in which the total refracting power of the left eye is in the area of 5 diopters more than that of the right. The retinal image therefore in the left eye uncorrected, is smaller than that in the right. This is true because we see that the error subjectively is 5 diopters greater in the left eye than in the right and hyperopia is present. The right eye has either 5 diopters more power refractively or is longer in length than the left (of course we realize it may be half and half)—but since the powers of the primary meridian indicate a difference of 5 diopters—doesn't the *possibility* swing toward a refractive rather than an axial difference? From there we can get an idea of the retinal image difference. After all, one does get some satisfaction in determining this, and it certainly is helpful in determining whether deep-curved or flat lenses should be given this patient.

During the past few years, some exceedingly important research and investigation of ophthalmometric readings and their variations with the subjective and retinoscopic findings has been accomplished. Many optometrists are unfamiliar with the reports of these investigations made by MacElree and Morrow[2] and also by Neumueller[3]. The value of these reports is great. In MacElree's and Morrows report it is clearly shown that the keratometer, even when interpreted correctly, taking both effectivity and physiologic astigmia into consideration, does not always give us the "perfect answer" due to the fact that the absolute index of refraction of each cornea measured is not exactly known. It is also pointed out that the three popular ophthalmometers each assume a different index of refraction as a basis for calculation. We may, then, in some cases be off as much as 2.00 diopters in our reading. Their conclusions are:

1. "The astigmia as indicated by the keratometer is only an approximation of the actual astigmia produced by the anterior corneal surface. The keratometer will give precisely the values of the radii of the cornea. These radii, however, when used in an effort to calculate the corneal astigmia are not sufficient for the purpose due to the lack of precise knowledge of the corneal index of refraction."

2. "The difference between the dioptric values of the two meridians on the cornea is no indication of the total corneal astigmia present."

3. "To estimate correctly the corneal astigmia, the index of each subject should be measured."

4. "The influence of variations in the index on small amounts under 1.50 diopters of astigmia does not exceed .13 diopter."

5. "The keratometer is subject to a possible source of error estimating the corneal astigmatism to the extent of from 0 to 2.00 diopters within the limits of the amounts of corneal astigmia usually encountered."

6. "Subjects having greater index than the one employed by the keratometer will accept more cylindrical correction in the final analysis than the accepted amount."

"7. The converse of the above is true."

Neumueller gives us splendid tables of exact calculation on the effectivity factor of the cylindrical and spherical corrections coupled with the physiological astigmatic allowance: incidentally every optometrist should keep these tables in front of him in determining his expected cylinder. Neumueller's second article clearly indicates why the resultant subjective and retinoscopic axes do not always agree with the axis as shown by the keratometer. This he finds is due to the fact that the physiologic lenticular astigmatism is usually 90/180, any oblique corneal astigmatism would tend to result in a total astigmia of a different axes, due to the resolution of forces, each force pulling in a certain direction, the resultant being somewhere between the two, closer to the greater value. Thus it is seen that a low amount of oblique corneal astigmatism will be more readily affected in resultant axis (total) than a high amount would. Neumueller has diligently calculated extensive tables with variations of corneal astigmatism in 5 degrees coupled with corneal and physiological astigmatic allowances. His table of allowances for physiologic astgmia is used at Pennsylvania State College of Optometry Clinics and is correct in the vast majority of cases. So often does it work out that any other result should be looked at with suspicion and checked. There is a great possibility that any discrepancy may be locked up in a hypertonus, the true astigmatic expected showing up after total relaxation of the ciliary to its normal tonus. If articles such as these were more widely read and digested by all refractionists many

false findings would not be prescribed and many points of doubt would be cleared up.

Continuing with our refractive procedure the tonicities or phorias are next taken. These should first be taken with the patient's old correction as it is essential to know what muscular imbalance is present when considering the patient's old habits of vision. It should be remembered that this finding (distance and near) varies in the same patient depending on the stimulus, light, time of day, attitude of patient, attitude of examiner, method of detection, etc. Thus we see how many variables enter. However, the above statement need not be taken for granted those doubting this, can easily prove it for themselves. This being true it is therefore impossible for anyone or any system to state a certain definite "expected," for instance, as 1△ exophoria or ½△ exophoria (at infinity) as some systems try to do, not only due to the above conditions mentioned, but also due to the fact that each patient has his or her definite norm, which may or may not be normal for him. It is physiologically impossible to expect a certain definite prismatic finding in these neurological tests as the eye is not a machine, but a part of the human body, controlled by a highly sensitive nervous system which, as we all know, is very flexible. We should, therefore, look to an "area" expected rather than a single value. This area as determined at the Pennsylvania State College of Optometry may be from 1△ to 3△ of exophoria at distance. There are millions of persons existing the world over, who are perfectly comfortable as far as their ocular efficiency is concerned who have as high as 3△ of exoporia and in some cases even more. The phoria finding itself means absolutely nothing, it must be correlated with the refraction and duction values. Thus, the idea of getting alarmed over a small deviation from ½△ at infinity as a "sign" of "something wrong" is not tenable.

The phoria finding at distance represents in prism measurement, the sum total of all the nervous energy being sent out by the tonic center to the extra-ocular muscles when only the basic tonic convergence is in play, that is, exclusive of all the other types of convergence, namely, accommodative-convergence, fusional convergence and proximal convergence. The phoria finding *may* (remember *may*—depending on certain conditions) give us some indication of a refractive condition of hyperopia or hypertonus and myopia. It is possible that excessive ciliary action may in time produce some disturbance in the relative positioning of the visual axes in the phoria test. However, the relationship between accommodation and convergence in this case would have to be very great, i.e., a large amount of accommodation-convergence and convergence-accommodation and a rather high activity of the ciliary would have to exist. This then may result in a finding of esophoria or a reduction of exophoria. However, hypertonus or excessive ciliary activity does not *always* produce an esophoria or a lowered exophoria as many men are prone to believe, in fact, in a great

many cases there is no effect on the extra-ocular muscles; the "whys" of which will be discussed. One method of proving that is by adding concave lenses to the patient's correction at distance and in many cases it will be seen that the phoria finding will not be changed until a high amount of minus is added. Why do some men believe that an excessive accommodation activity always results in an esophoria? Because, they say, if a person accommodates, he brings in convergence (use of accommodative-convergence reflex) thus creating the new relationship. However, if it is proven that accommodative-convergence is not used under normal conditions of fixation, wouldn't that tend to disprove the former reasoning? Wouldn't it also tend to disprove the idea of fully correcting myopes with exophoria, etc., and the principle of effecting the relationship of the visual axes through the accommodative center? The recent investigations of Edwin Forbes Tait, William J. Tait and W. O. Vivian lean toward the belief that this associated reflex is not in use under ordinary conditions, the only time it comes into play being when accommodation is dominant. Thus it comes into play during the phoria test and possibly in highly uncorrected hyperopes with a close and high accommodation-convergence relationship. Tait bases this view on first, the fact that upon plotting the amounts of accommodation-convergence distribution of several thousand clinical cases (Vivian), a Gaussian or learning distribution curve is produced. Learned reflexes come into play only when one of the prime stimuli are absent or on high dominancy of one over the other. Secondly, thousands of cases with low amounts of accommodation-convergence or high exophoria at near are perfectly comfortable, ocular efficiency not being interferred with. Since it has been proven that accommodation-convergence is a learned reflex, possessed in quantity by some and but little by others, this shows that this reflex is not wholely necessary for visual efficiency. Dr. W. J. Tait's [4, 5, 6] experiments on the fusional convergence amplitude also confirms this belief. Here is absolute proof, no arm chair "philosophy." I refer to those splendid articles by E. F.[7, 8] and W. J. Tait and Vivian[9]. Before leaving this phase of the work, let me quote from a recent article by E. F. Tait: "In a survey published several years ago, Vivian demonstrated the Gaussion character of the distribution of accommodative-convergence in several thousand clinical cases and showed definitely that visual comfort and efficiency did not depend in any way upon the amplitude of this reflex. He further demonstrated that accommodative-convergence was a true associative reflex, present usually because of the simultaneous use of accommodation and convergence over a period of years. This viewpoint was fully sustained by an experimental program undertaken and recently reported by Dr. W. J. Tait, in which he demonstrated that there was a very close correlation between the relative amplitudes of the adductive blur points and the amount of convergence accommodation possessed by the subject." Isn't all this scientific proof, based on sound accepted experimental principles. A proof that

accommodation-convergence is not used normally? If so, then see how the present theories of some of the new refractive systems break down. Then, one may ask, of what use is the value of knowing the amount of accommodation-convergence. It is valuable as shown by Tait in the interpretation of dynamic skiametry, in probability of hypertonus, and in certain nervous conditions as hysteria, etc.

We next proceed to Dynamic Skiametry. The two types of Dynamic Skiametry used are: E. J. Tait's system[10] for individuals whose age is from 10 to 40, and Sheard's[11] system used in individuals from 40 on up. Tait's method gives us the true or total correction that the patient should accept or eventually will, whereas the Sheard method is used to determine the presbyopic addition.

Some systems of case procedure use a form of dynamic skiametry at different distances where allowances are made without the knowledge of why they are done, no definite experimental data being performed to prove their value and plausibility. Seventy-five per cent of such men do this mechanically, making such and such allowances, not knowing in their own mind whether it is right or wrong because they don't know *why!*

The Tait system of dynamic Skiametry has been planned, developed and constructed along sound, scientific and known physiological principles. Facts, figures and experimentation show *why* it is correct and logical. In order to fully appreciate the tremendous amount of work done to develop this method, the reader should digest Tait's reports on this subject. It is not within the scope of this paper to go into the theory and technique of the system, but to impress upon the reader's mind that definite proof of the results and sound basis for the technique, are answered fully and definitely.

The Tait system used in our practice is practicable. It gives us the basic or true correction. It is not claimed to be a "cure-all" but is correct in 80 per cent of the cases, if performed properly. A higher finding in plus or a lower finding in minus, therefore, in 80 per cent of the cases, indicates a hypertonus or abnormal tonus of the ciliary muscle, the relaxation of which should be attempted by known methods. In some cases the dynamic may come out lower than the static, which when the theory is understood, will be seen to be due to the fact that the proper relation between accommodative-convergence and convergence accommodation does not exist. The belief of this author is that some cases of so-called asthenopia, due supposedly to "extrinsic" muscular unbalance, are really cases of hypertonus, the abnormal tonus (in a young individual) when relaxed to the point where the patient accepts the dynamic equal to the subjective, will then disappear.

The methods devised by our men of getting rid of this hyper tension of the ciliary are many, like base in exercises, over correction in plus (bad policy), bifocals, etc. The best method is in either a full

dynamic correction for near work only, or bifocals. To get rid of "bifocal objection" we can prescribe the subjective modified accordingly and a fitover for reading with the add inserted.

Not much can be said of static skiametry except that we all know how exceedingly important it is that we are all efficient, and masters of this technique. Both eyes should be fogged, the patient being warned that the fixation target at distance will be blurred. Request that he should not make an effort to see the object clearly. Try to get directly in the line of the visual axis of the eye being scoped. (Right eye on right and left eye on left). A good method of getting neutralization is to decrease plus until a fast against motion is seen, then if .50 less causes a with, take .25 less as neutralization.

This author has consulted an advocate of a popular new refractive routine as to *why* a lowered static tends to point toward a toxic condition. The explanation given was that, when one eye is scoped, fusion is broken and toxin in the third nerve center causes excessive stimulation of the convergence centers (esophoria) with its consequent stimulated accommodation, which results in less plus being found statically. The esophoria or less exophoria is about 1△ to 3△, usually as is indicated by the phoria finding. Quite a theory. BUT. In these cases, or in any case of "less static finding" let us take the adduction at distance and near. The first blur may be 5△, 7△ or 10△, however seldom is it lower than 4△. In many cases it doesn't even exist. This blur indicates the *stimulation of accommodation;*—isn't this true? Then if it takes 7△ to 10△ to stimulate, accommodation very slightly, how is it possible that 1△ of esophoria or 1△ or 2△ less exophoria in the static test stimulates .50 or .75 D. of or ciliary activity? Think this over and ask yourself, if under one test it takes 7△ or 10△ to stimulate accommodation to a very slight extent how can 1△ or 2△ in another technique stimulate accommodation .50 or .75 diopter or whatever the difference between static and subjective is? This author sees a difference in static and subjective as:

1. We are dealing with a variable human whose prime purpose during the subjective test is to see the letters as clearly as possible. It is *his* interpretation.
2. Not scoping along visual axis.
3. Faulty technique.
4. Improper allowance for working distance.
5. Working distance not accurate at all times.

The subjective test or "patient's answers" is our next step. Very little can be added that is not already known as most men are proficient in this procedure. After each eye has been corrected, the visual acuity of each eye should be balanced if possible by placing 3△ base-down over one eye and 3△ base-up over the other so that displacement and absorption shall be equal; also by fogging each eye .50 D. diopter. Balancing

of visual acuity should not be done in the average case, however, if the corrected vision of one eye is below normal while the other is normal, the full refractive error should be corrected. (This does not necessarily hold in treating amblyopic cases.)

In low degrees of astigmatism the axis of the correcting cylinder is oftimes difficult to detect even with the aid of our keratometer. Two very good charts used for this determination are the "V" chart and Thomas Astigmatic Chart in which both bars are rotated until they are of equal intensity. This test is of far more value than the "antiquated" fan dial in which the patient gets confused at the large number of lines. In the Thomas chart only two lines are present, these two concepts of distinctness being present in the individuals' mind at one and the same time. It is surprising with what accuracy the two principal meridians can be located.

In cases of presbyopia, the patient (in the average case) should be handed a paper or card and instructed to hold the card where he or she would *like* to read, this distance should then be measured with a tape measure. The add is prescribed accordingly. However, it all cases the patient's age, occupation, amplitude of accommodation and habits should be taken into consideration.

The amplitude of accommodation for each eye separately is taken in the usual way at 13 inches with small type about 3mm. in size. Plus should be decreased or minus increased until the first perceptible blur or haze occurs, this if not cleared in a few moments indicates the secondary focus is off the retina and the lens before the blur is taken as our value. Some men take the point where the patient is unable to read the letters as the value, this however is not a good method as the patient simply interprets the blurred retinal images and thus *apparently* overcomes the added minus.

Any radical difference in amplitude between the two eyes should be looked at suspiciously and further investigation of the nerve pathways should be made, whereas a small difference should indicate a check up of the distance correction. The amplitude should be compared with Donder's table, any notable deviation in the negative direction should be looked at suspiciously, lowered amplitude may indicate glaucoma, third nerve involvent, disease, or lowered nervous response, etc.

The phoria test with the subjective is taken at distance and near, the findings compared with the findings when the patient came in. The near phoria tells us the amount of accommodative-convergence an individual has. An excessive accommodation-convergence as a very high esophoria at near may indicate abnormal accommadative activity or a nervous lesion where a normal stimulus gives us an abnormal response.

The duction tests indicate the measurement of activity of the fusional center in order to preserve single binocular vision. In most cases if the duction value is 2/3 greater than the phoria of the opposite

direction, the patient will be comfortable; otherwise orthoptic treatment may be necessary.

The blur point, break point and recovery should be noted. The blur point indicating the efficiency of the accommodative-convergence and convergence accommodation reflex. The break point indicating the value in prism diopters of nervous energy the fusion center is able to send to the extra-ocular muscles; and the recovery point indicates the quality of fusion or *desire* of the individual for single vision. It may indicate the number or efficiency of the fusional receptors in the extra-maculay field (W. J. Tait). A low reversion to fusion also indicates orthoptic training.

Visual fields, when any case is suspicious as far as glaucoma or any disease, general or ocular, should be gone into and if such suspicions are confirmed—the patient should undergo a physical examination by a competent physician.

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PHOTOGRAPHING THE EYE MOVEMENTS DURING READING, AN OPHTHALMOGRAPHIC TECHNIC*

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A. Introduction

For more than half a century, experimental work in applying eye movement photography in reading has been carried out by many investigators—Dodge, Clark, Eames, Miles, Judd, Tinker, Vernon, Euric and others being interested in this subject from different angles. Most of the investigators have used a laboratory approach to the problem. It is only of late, since the introduction of the Ophthalmograph that an attempt is being made to apply clinically the technic of eye movement photography.

The reason why this technic was not introduced into the clinic until now was due to the fact that the early model cameras were of very large size. An instrument of this type would require a large size room for itself, this coupled with the very high cost, made it practically impossible for the optometrist to utilize this technique clinically.

However, the development of the camera has undergone an evolutionary process. At first it was very crude, next it was refined (but too large) and finally the ophthalmograph (a small portable size) was introduced as shown in Figures 1 and 2. Not much clinical data is available at the present time, but from the small amount of data published to date one can not help but feel that the Ophthalmograph may in the very near future prove to be a very important diagnostic instrument. In fact, as far as the writer knows, it is the only instrument available which will give us an objective clinical record of the behavior of the eyes under a dynamic condition. All the tests the optometrist applies in the refraction room, whether objective or subjective gives him information about the eye while they are in a static condition and we do not know whether the same condition prevails when the eyes are in a moving state. Clinical eye movement photography will furnish this information to the optometrist, and it probably will become, in the very near future, a diagnostic instrument of some clinical significance.

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*An abridgment of the material presented before the Minnesota Academy of Optometry at Minneapolis, Minn., Dec. 29, 1935.

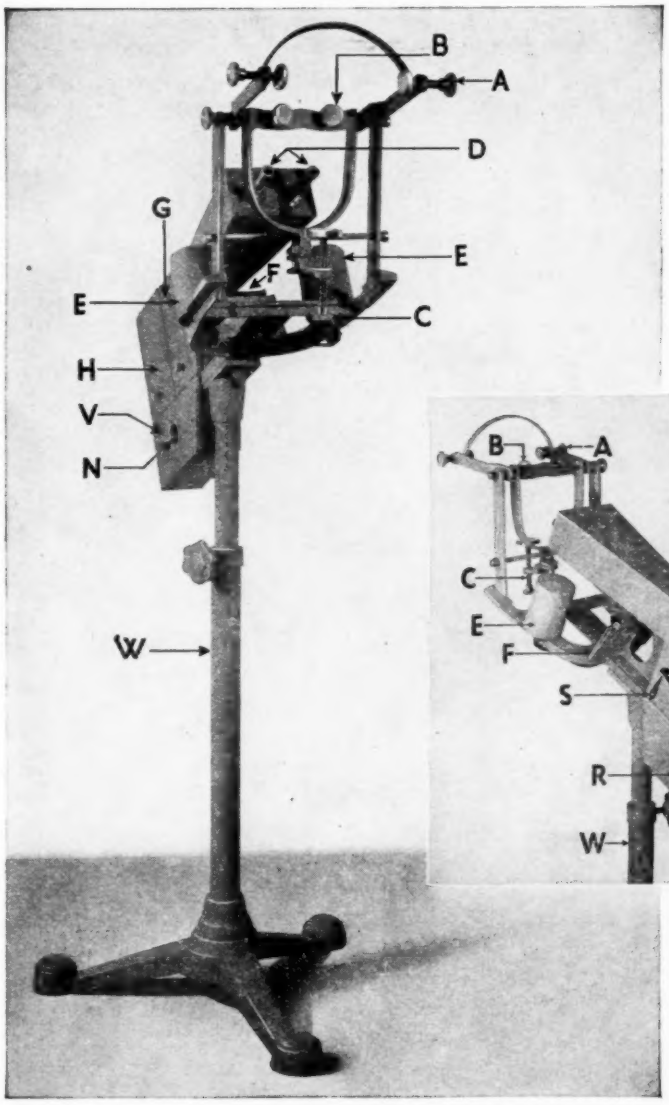


Figure 1

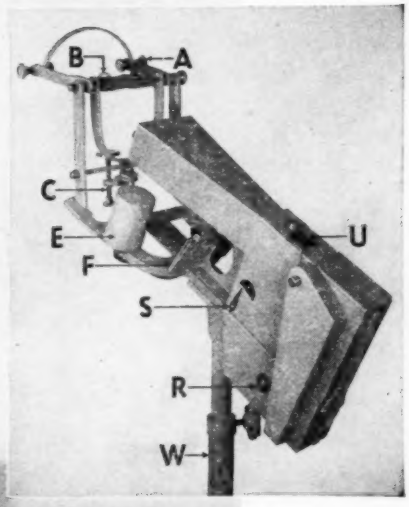


Figure 2

B. The Technic of Eye Movement Photography

The technic is simple and with a little practice can be applied by any optometrist or his assistant.

Figures 1 and 2 illustrate the Ophthalmograph.

A. Headrest Temple Adjustment.
B. Headrest Forehead Adjustment.
C. Headrest Chin Adjustment.

D. Focusing Telescopes—Adjustable in and out and rotatable in all directions.
E. Lamp Casing.
F. Reading Card Holder. Cover card holder contains directions for patient. After directions are read this card is lifted and the test made with reading card in bottom holder.
G. Compartment containing unused film.
H. Compartment containing exposed film.
R. Motor Switch.
S. Indicator shows amount of unused film.
W. Adjustable stand.

Figure 3 illustrates the Principal of the Ophthalmograph. The subject reads the card at F which is illuminated from the lamp E. Rays of light from this lamp which fall upon the camera are reflected into the telescope and are focused by lenses of the telescope upon the

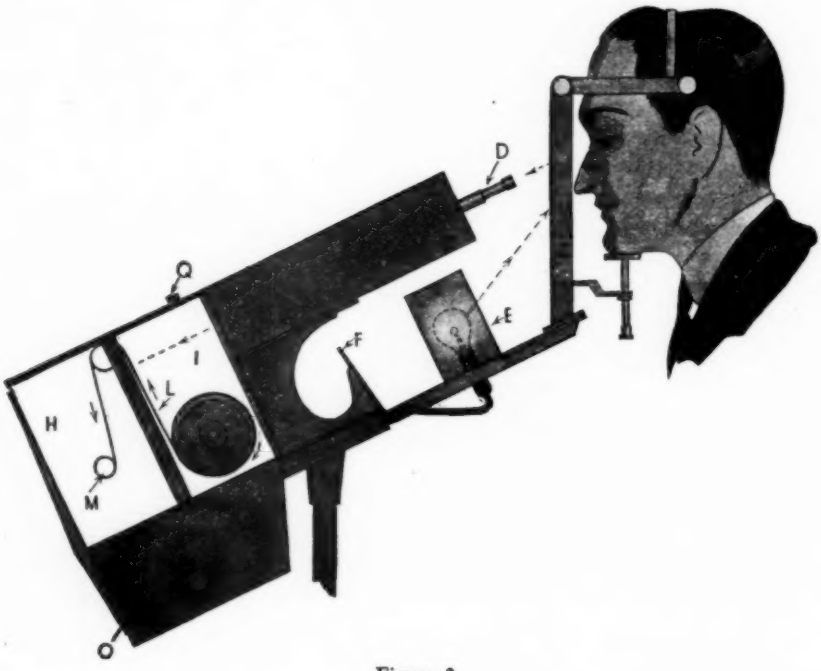


Figure 3

film. This film travels through the camera upwards as indicated by the arrow at L at a fixed speed of half an inch per second, while the eyes move horizontally across the line of print. The movements on each line are so recorded that the record appears like a double stairway as

illustrated in figure 4. Care should be taken in adjusting the subjects head into the proper position. It should be in a position like that illustrated in figure 3. If it is lowered too much or raised too high it will be difficult if not impossible to get the rays from the cornea reflected into the telescopes. When the head is once properly adjusted the telescope D is pulled out half way and then rotated in different directions until it intercepts the ray of reflected light from the cornea. This once accomplished the reflection will show upon the view finder at U.

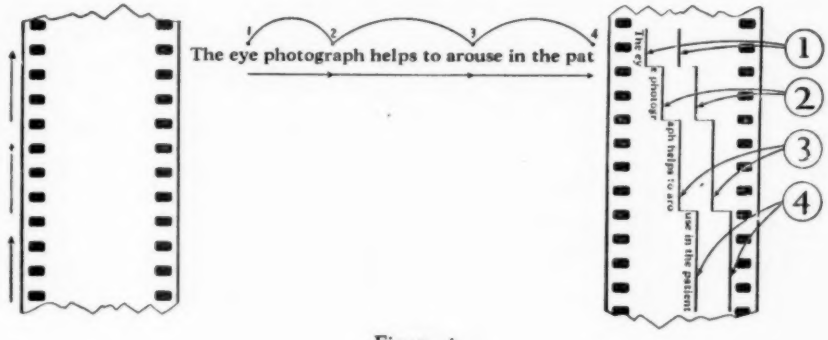
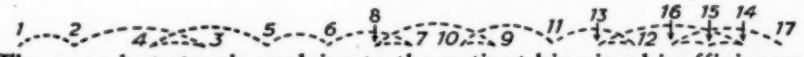


Figure 4

Extreme care should be taken that when the camera is once set in motion to see to it that both the film feed and take-up "M" operate at the same time. It is advisable to work rapidly in adjusting and focusing the camera for if this is prolonged, excessive lachrimation may result on account of the bright light thrown directly into the eyes from E. When a film of tears once covers the cornea it then becomes very difficult to produce a fine uniform focus of the rays of light projected from the cornea.

Figure 4 illustrates the record made by the reflected rays of light while reading. On the left side will be seen the blank film. On the right is seen a double stairway produced from the four movements made by



The eye photograph explains to the patient his visual inefficiency.

Figure 5

the eyes while reading the line. "The eye photograph helps to arouse in the path." It will be observed that in reading this line the eyes made four distinct and clear cut movements. Compare these movements with those shown in figure 5. It will be noted there that at points 3, 7, 9,

12 and 14 the eyes made a return movement, this is known as regressions. In figure 6 are illustrated regressions as they appear on the photographic record. Here one will observe that the stairs are not

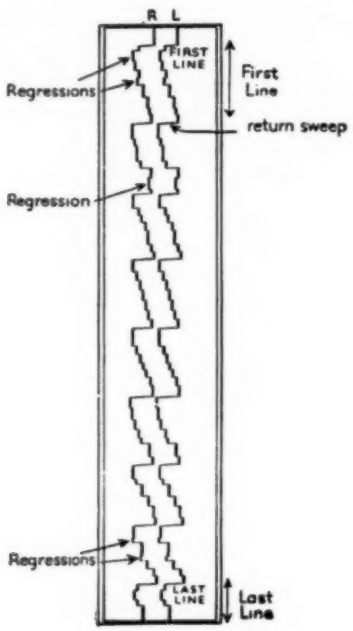


Figure 6

uniform and the movement is not constantly to the right but there is an occassional backward movement to the left which forms the regression.

C. Analysis of Ophthalmographic Record.

When the record of the Ophthalmograph[1] is once developed the following information may be obtained from it.

(a) Reading Speed. (b) Number of fixations. (c) Number of regressions. (d) Duration of each fixation. (e) Span of recognition.

Figure 7 illustrated the movements of a normal pair of eyes. To determine the number of words read per minute the following formula may be used:

$$\frac{\text{S. W.}}{2 \times \text{FL}} \times 60 = \text{Reading speed per minute.}$$

S. W. = sum of the number of words in the test.

F L = film length expressed in inches.

[1] We wish to acknowledge our indebtedness to the Scientific Department of the American Optical Company, Southbridge, Mass., for the kind permission of the use of some of the illustrations, as well as of some of the material quoted freely in this article.

If for example the reading card contained 100 words and the film length is 12 inches we have $\frac{100}{2\times12} \times 60 = 250$ words is the speed of reading per minute.

To determine the number of fixations the eyes make per 100 words we may use this formula:

$$\frac{S\ (F+R)}{S\ W} \times 100 = \text{number of fixations per minute.}$$

F = Fixations.
R = Regressions.
S W = Sum of the number of words in the test.
S = Sum.

Example: If the number of fixations and regressions in the test was 75 and the number of words in the test 100 then $\frac{75}{100} \times 100 = 75$ fixations per 100 words. The number of regressions is similarly calculated using the same formula we merely substitute the number of regressions in the test in place of (F + R).

The span of recognition is determined by dividing the number of words in the test by the number of fixations and regressions.

In calculating the number of words the patient was able to read before treatment was started and after treatment was completed one should be certain to use a different card in each test, also the material of the two test cards should not only be of equal length but of equal difficulty as well, otherwise the photographic records will not be of any value for comparison purposes. Chapman worked out a number of test paragraphs which are of equal length and equal difficulty. Two of these paragraphs are shown here[2]:

CARD 1

1 2

1. Tom got badly hurt the other day, when fighting with his older brother. As soon as this happened, he ran home to his mother, laughing[2] as hard as he could. 2. The woman burned herself badly, while she was making soup for our Sunday dinner, just because she was so careless as to tip over a pan of cold water. 3. One day we found something in the woods that had four legs, long sharp teeth, and thick brown fur, so we knew it must be a bird of some sort. 4. We started to cut down a tree in our front yard, but, after working for two

[2] There is one word in each section which spoils the meaning of the section. In order to discover these words the subject must pay close attention to the reading task.

hours and a half, we gave it up, because our hammers were no good. 5. Jack never seems to look where he is going, and is always stubbing his toes, and falling over things. I think anyone who does that is rather clever, don't you?
3 4

CARD 2

1 2
6. The farmer said we could have two quarts of milk and a quart of cream tomorrow, but we would have to bring a couple of bags to put them in. 7. Some people have what is called a "sweet tooth." They are fond of sweet things, put lots of sugar in their coffee, and often eat lemons for the same reason. 8. John did his work so well, and got such good marks during the whole of the year, that his teacher thought he would be sure to fail in the examination. 9. When one goes on a picnic, and takes along a big pail of lemonade, it is very provoking to find someone has forgotten the forks, and left them at home. 10. The old schoolmaster was very harsh and cruel to the boys, and beat them when they made mistakes, so, when he left all the boys were sorry.
3 4

TABLE 1

SILENT READING EYE MOVEMENT STANDARDS (APPROXIMATE)

Based on Standard Reading Material for the Various Levels

GRADE	Low 1	High 1	2nd	3rd	4th	5th	6th	7th	High School	College
Av. Fixations										
Per 100 words	250	210	147	124	103	100	97	95	93	80
Av. Regressions										
Per 100 words	67	53	45	40	30	22	20	19	17	10
Average Speed									260-	320-
Per Minute	20	45	90	138	168	182	216	230	300	350

It is important that the patient understands exactly what is expected of him, we therefore use one extra card for practice. The writer instructs the patient to look at the number 1 at the left end on the top of the first line on the card. He is to hold his eyes fixed on 1 for 2 seconds then he is to fix them on number 2 which is at the right end on the top of the first line. He fixes on this point for 2 seconds then he is instructed to read, when he completes reading he is to look for 2

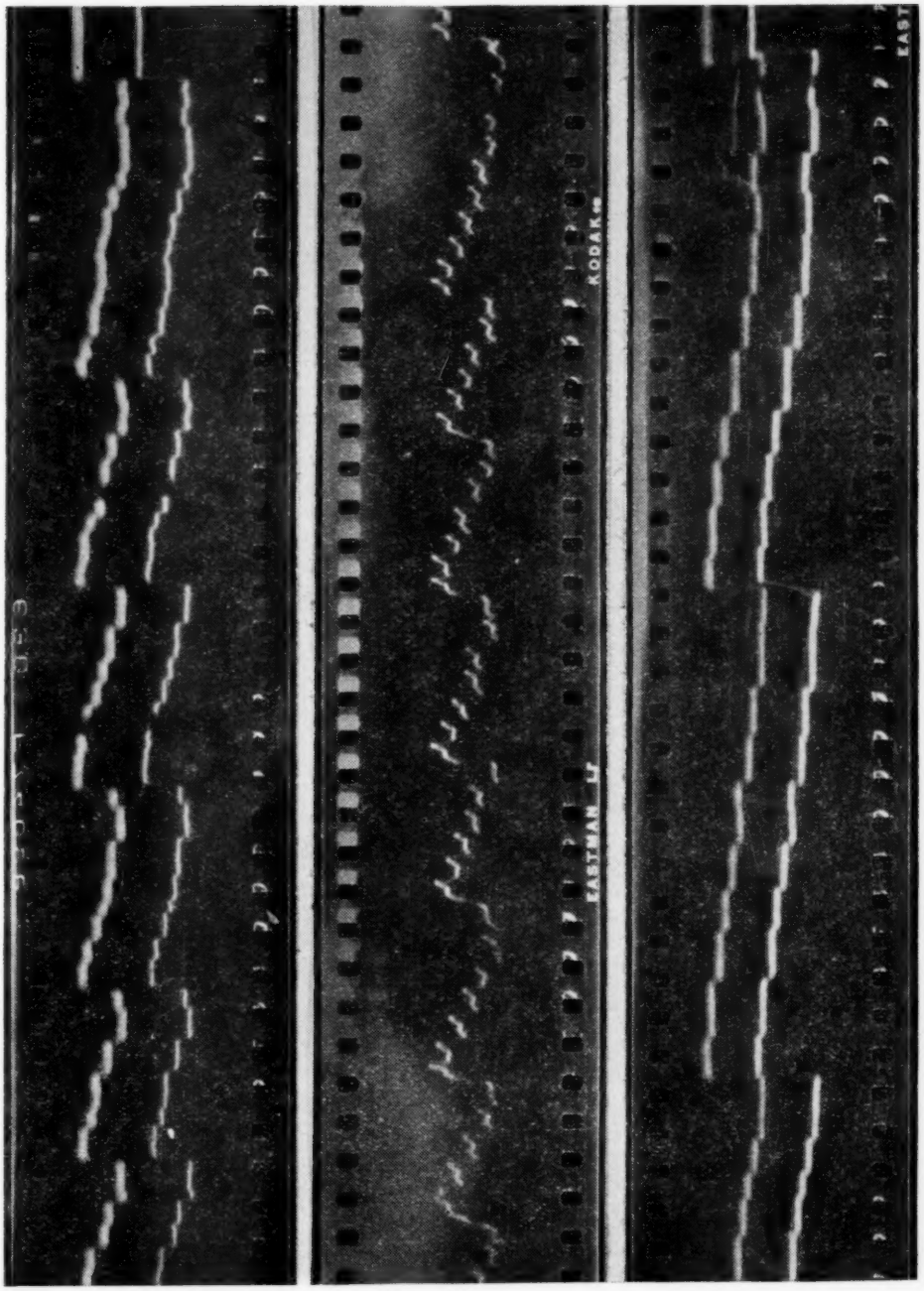


Figure 7

Figure 8

Figure 9

DR. J. I. KURTZ

seconds at number 3 which is located at the left immediately below the last line and next he is to fix his eyes on 4 which is located at the right end of the card immediately below the last line. We have the patient repeat the practice two or three times before the first photograph is actually taken.

D. Value of Ophthalmographic Records from a Clinical Standpoint.

1. The importance of a permanent objective clinical record can not be over-estimated. The Ophthalmograph offers the optometrist such record.

2. When a case is treated for some time, it is possible to watch the progress of the case by studying and comparing the photographs.

3. We have no quantitative test for nystagmus. Figure 8 represents a record of a nystagmus condition, another photograph taken after treating the case for some time will show definitely if there is any improvement and its extent.

The record in Figure 7 is of a patient with a normal reading ability of 320 words per minute, that in Figure 8 is of a convergent squint case with a very marked rotary nystagmus. This patient can read 280 words per minute. In Figure 9 is recorded the movements of a pair of amplyopic eyes slight horizontal nystagmus with a refractive error O.O — 1.50 D.S. ⌒ + 5.50 D.C. Axis 95; O.S. — 1.50 D.S. ⌒ + 6.00 D.C. Axis 85. Visual acuity with these lenses is 20/50 O.U. and the patient can read only 100 words per minute.

4. Oftentimes the phoria test at near will show orthophoria, yet during the act of reading the eyes may develop a convergence or divergence or a vertical phoria, we had no technic until now which would

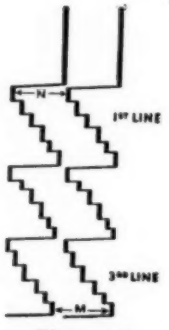


Figure 10

enable us to detect the development of such condition. The Ophthalmographic record will enable us to discover such abnormalities. Figure 10 illustrates a change in the convergence after reading three lines. The

distance N at the beginning is smaller than the distance M at the end of the third line.

5. The photographic eyes movement technic may open up new avenues for optometric research. The writer is making use of this technic now in a research problem on ocular fatigue at the University of Minnesota, the result of which will be published in this Journal in the near future.

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SOME CIRCULATORY CHANGES CAUSED BY OCULAR FIXATION OF SELECTED LIGHT FREQUENCIES IN THE VISIBLE RANGE*

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In June of 1919, Dr. F. P. Barr suggested to a group of graduate students during a course of instruction at Ohio State University, that the use of a cobalt-glass filtered spot light at a relative infinity as a fixation object during static skiascopy might result in sufficient relaxation of the ciliary as to secure more stable findings, particularly in the hypermetropic cases. During the same course of instructions Dr. Charles Sheard, then head of the Department of Applied Optics at Ohio State University, suggested that the findings in static skiascopy might possibly be more nearly correct if light were used that consisted primarily of energy in the region of maximum visual acuity. He suggested the use of a deep amber filter in the self-luminous retinoscope with this thought in mind.

The suggestion of Barr was put into use immediately upon return to my practice, and it seemed that there was less of the shifting of the reflex between "with" and "against" that is so common in spasm of accommodation. This method was used for several months with entire satisfaction. Sometime in the winter of that year the suggestion of Sheard was also put into practice, but with its use, in conjunction with the cobalt-glass filtered light at a relative infinity, it was found that there was less apparent stability than when the cobalt-glass filtered fixation object was used with the ordinary white light in the retinoscope.

In an effort to find some reason for this a search of the literature was made and the first contact was with a work by Major Pleasantson,[1] in 1861, in which Pleasantson set forth some of his findings on plants and animals in conjunction with a patent he secured for the use of alternate strips of filtered and white light for use in greenhouses. While Pleasantson's work gave a slight clue it was not until a work by Babbitt[2], published in 1876, that any real material, largely empirical, was obtained in reference to the effect of filtered light upon human beings.

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*An abridgment of the material presented before the American Academy of Optometry at Cleveland, Ohio, December 18, 1934.

In the summer of 1923 Dr. F. F. Wilcox and the writer did some experiments with rabbits using filtered light. In the fall of the same year at the writer's suggestion a friend carried on a series of experiments with gold fish under filtered light. It was found that under some types of light cataracts developed, together with a fungus growth among the scales of the fish while under other types of light these effects were not apparent. The researches of Burge[3] at much earlier date, were consulted in this connection as were those of Crooks[4], both of whom had made a study of the effect of radiant energy in the visible range on the eye, the former in connection with the formation of cataracts.

Further light was shed on the problems involved by a suggestion made to me in May, 1925, by Dr. Arthur E. Hoare, of Los Angeles, in which he referred me to a book by Raup[9]. This book proved of great value in providing a leading thought and a means of approach to the possible mechanisms involved.

In a book completed in 1925 by Luckiesh and Pacini[5] the authors stated that the effect of visual stimuli can be observed in the blood pressure, in the muscular system and in the nervous system. With these statements as further clues the researches of Pressy[6] were further studied as they pertain to the effect of visual stimuli on the voluntary muscles.

Further, a study was made of changes in blood pressure as affected by visual stimuli, using a recording instrument, in an effort to determine just what light frequencies had the most marked effect thereon.

The work of Emil Weil[7], as reported in medical literature, seemed to indicate that there was some very definite connection between ocular stimuli and reflexes resulting therefrom and the heart muscle itself. This seemed true in view of the fact that Weil's test is used by cardiologists to differentiate between functional and organic heart murmurs. Until quite recently this was the only definite reference in the literature to the effect of ocular reflexes upon any of the supportive functions thereof. Someone has said: "The eye complains through other organs much of the time, and the seat of trouble can be diagnosed only by the specialist." Williams[8] has since gone to considerable length to list a number of supportive function departures from the normal due to ocular deviations from the normal.

Experimentation was first done by radiation of the entire animal which was later limited to the eye alone, because of material discovered in research reading and as a reversion to the original thought obtained during the University course first suggested to the writer by Barr.

In order to have a fairly clear picture of some of the changes occurring and illustrated in the original tracings made at my office, you should keep in mind that the circulation of the blood is basically the end result of a number of processes operating simultaneously. First, the circulatory system is a closed system of tubes, and speaking from a hydrodynamic standpoint, may be likened to a U-tube and syphon connected end to end, while at the connecting point there is a check valve

arrangement which is self-operating and determines the direction in which the blood shall go. Keep in mind that the arterial system is composed of vessels having a muscular coat and that this muscular coat maintains a constant contraction against the contents of the artery, which, since the valve in the heart is closed behind the column of blood, forces it to move in one direction—forward. Recent investigation shows that the tonicity contraction of the striped muscles is one of the major factors entering into the movement of venous blood and its return to the heart. Bear in mind that the veins contain valves which open centripetally and tend to hold all blood which is forced above them by either skeletal muscle contraction or muscular tonicity. And finally, and perhaps basically, we have the respiratory act which is considered by some physiologists to be the major act for the maintenance of circulation. But respiration itself is under control of a brain center which seems to be activated by an excess of carbon dioxide in the blood. Undoubtedly, there are other factors, but the ones named seem to be the major ones in the maintenance of flow.

Since the blood vessel system is a completely closed system it is obvious that any externally applied pressure to the vessels will tend to raise the internal pressure within them. Furthermore, any excessive contraction or dilation of the plain muscle composing the arterial walls will tend to raise the blood pressure or lower the pressure within the circulatory system. The plain muscle, of course, maintains a more or less constant contraction due to the inherent qualities of plain muscle to contract. Furthermore, there is the vasomotor center in the central gray, which, if it does not control the contraction or relaxation, apparently controls compensatory contraction and dilation, thus maintaining blood pressure at a relative constant for each individual if and when compensatory contraction or relaxation has been established. Obviously, if this compensation is disturbed there will be alteration of the blood pressure either up or down. The tracings merely show some disturbances of the control by throwing the compensatory mechanism into confusion. Some of these tracings will show a rise of systolic pressure and a drop of diastolic pressure. Others will show a simultaneous drop of both systolic and diastolic pressure, and some will show not only a rise in systolic pressure, but a lack of rise in diastolic, with a consequent increase in amplitude.

Due to the susceptibility of blood pressure to physical changes due to position, food intake, and other causes, a sincere effort has been made in each of these tracings to change only *one* environmental condition between the making of the first and second tracings. After the subject had been quiet for a number of minutes and the pulse rate counted at intervals of five minutes and the same count made at three successive counts, the first tracing was made. The only environmental change between tracings was the change of light frequencies incident into the eyes of the subject, the same frequencies yielding similar tracings in different subjects.

Incidentally, experimentation has been done by the use of plus lens, minus lens, prisms and ophthalmic tints, and it has been found

that they also make changes which can be reasonably anticipated. However, the tracings mentioned were made by merely changing the one environmental condition, by *using a selected light frequency band in the photic range.*

It is not the purpose in this paper to make an effort to explain the results but merely to present the facts as they occurred.

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QUESTIONABLE PRACTICES IN OPTOMETRY

If optometry is to continue to be considered a profession and be recognized as such by the public it is very important that we keep our own house in order and that we purge ourselves of all questionable commercial practices and all questionable teachers and teachings.

Optometry, it seems to the writer, has been under a condition of hypnosis during the past few years. While under this hypnotic influence it was possible for certain persons to convey to optometry many fanciful statements which would bear little or no investigation. They substituted first rate salesmanship for scientific facts: emotional revivalism in the place of education.

It is gratifying, however, to note that there were many optometrists who could not, and would not be so hypnotized, and that now many others are awakening. Considerable correspondence regarding this subject has reached our desks of late. One of the leading educators from California writes, "Some of the things that pass for education are grossly unscientific. Some of the methods used to disseminate that type

of education are outrageous." Space will not permit us to quote or discuss all of these letters. We will therefore quote only one letter which will suffice to illustrate a present trend of optometric thinking. The correspondent is a young ethical practitioner. He writes:

"Our profession will do well to follow the ethical practice of medicine in regards new techniques et cetera. In the first place, half baked and unproven ideas are not given much attention by the medical magazines or by the profession itself.

"A short while ago a medical friend told me of some brilliant work in an original field that he had found out about. I suggested that he present the matter to the medical journals. His reply was, 'No, they would laugh at me. I would first have to follow out his treatment on a large number of patients.'

"When our dental or medical friends discover new techniques, the invariable plan is to present the matter to their profession through their county and state societies' meetings and then through their journals, without any thought of remuneration or idea of trying to commercialize on the idea. This is the only professional course that any professional man may follow, especially in the Healing Arts.

"On the other hand, what do we find in our profession? A thousand and one gadgets that are not worth a whoop, a hundred and one schemes, courses and plans to make money are offered us in ever increasing numbers, and it appears that quite a number of the profession are falling for this sort of thing.

"About the only remedy that I see at the present time for those not well enough grounded in ethical or economical decisions when approached with this and that gadget or pet scheme, is to consult with some member of the profession who is better posted and get the facts, and most decidedly am I in favor of discouraging any plan that smacks of unethical commercialism.

"If any man or group of men have perfected a superior technique let him present it without secrecy and price, as the other professions do, to all optometrists as Koch says 'with evidence of the value of these suggested techniques, and a sufficient number of clinical case reports' to make them stand up, as well as through the medium of technical papers, dealing with the theoretical and practical side of the work, all of which MUST first be presented with *nothing hidden*, to the profession through its technical journals and other ethical mediums."

Elsewhere in this issue of this Journal appears an article entitled, "A Discussion of Some Present Methods of Case Procedure and Their Interpretation," by Norman A. Zevin. This article is very worth while reading, as it illustrates a type of mental approach to optometric problems which will slowly but surely give us the firm factual foundation

the profession needs and which will, in the end, make it very unpleasant for those of our men interested chiefly in selling a smattering of scentific knowledge for as much as the profession can be talked into giving.

Jack I. Kurtz.

* * * * *

SPECIAL REPORT

A PHILOSOPHICAL STUDY OF OCULAR FUNCTIONS*

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"He who seeks wisdom in the fountain of wisdom is a true disciple, but he who seeks it where it does not exist, will seek for it in vain."—Paracelsus.

Professor Albert Einstein tells us that energy and matter are interchangeable. Immediately, we wonder, is it mere speculation, or is it possible to prove that statement? Philosophically, we may satisfy ourselves with a logical explanation, arrived at through deductive reasoning, but scientifically, we are as yet, apparently unable to satisfy all minds, that such a statement is correct. Therefore, lest we encounter too many obstacles, let us proceed philosophically, beginning with a scientific foundation, soaring into the realm of speculation to our hearts desire without losing sight of the scientific facts upon which we stand.

It seems that an attempt to understand a part of anything without a fairly clear concept, and due consideration of the whole is futile. It is looking for the truth where it does not exist. Since the ocular functions are a part of man, man is a part of this planet, this planet is a part of our solar system, and our solar system is a part of the universe, it would seem logical to begin our investigations by delving into the laws that are common to the universe as a whole.

It seems to be quite generally believed that the stars we observe in the sky are similar to the sun in our own solar system, and that while we are unable to see the planets traveling around each one of them, they are nevertheless there. Thousands of solar systems like the one of which our earth is a part, with the sun in the center and a number of huge spheres sailing around it at a terrific rate of speed, governed by the laws of attraction and repulsion are a part of that mysterious, and vast, expanse we have chosen to call the universe.

Someone has said "as the large, so the small." Let us investigate and see whether or not we can satisfy ourselves that that statement is

*An abridgment of the material presented before the Minnesota Academy of Optometry at Minneapolis, March 29, 1936.

correct. Let us descend from the realm of the stars to what is known to all of us as the atom.

An atom has been defined as "the smallest sub-division of any element, without losing its identity"; in other words, everything is made up of atoms. Physicists tell us that an atomic system is quite similar to our solar system. That is, the atomic system is composed of minute electric charges rotating in their respective orbits at various distances from a mass center, and these points are no closer together in proportion to size than the planets in our solar system.

Then what is an electric charge? It can hardly be called matter, as we understand that term. The best name that can be given to it is perhaps energy. Then, if an electric charge or impulse is energy, and an atom is composed of it, and all matter is composed of atoms, what has happened to our material world? It may be said that "the universe is a form of vibratory energy, vibrating at different rates of speed, in different places organized under different forms." With that in mind, it would follow that, "the physical world as we perceive it, is an illusion to our physical senses."

With the foregoing remarks in mind, let us analyze the sense of sight to ascertain what really takes place during the act. In the first place we have energy in one form meeting the same energy in another form in a way that makes one respond to the action of the other. That is, light, a form of vibratory energy enters the eyes by way of the cornea which is the same energy in another form arranged in such a manner that it will change the course of light, converging it toward a point, or focus. Next it passes through the crystalline lens which bends it still more. Since the retina is a continuation of the optic nerve, or should we say the beginning or end of it, it should be reasonable to assume that the rate of vibration of the fibers of the optic nerve is changed when light strikes them and that this change is transmitted along the entire fibers to the visual centers in the brain and we become conscious of this disturbance and interpret it according to our understanding gained from past experiences or from others.

As stated previously, "this physical world as we perceive it through our physical senses is an illusion." Because the nerves of our five physical senses respond to a comparatively few frequencies of this vibratory energy of which our physical world is composed. A striking analogy is that of five tuning forks, being so tempered as to respond to five keys on the piano, each one in a different octave. Imagine anyone listening to a symphony orchestra playing Beethoven's fifth symphony, and his auditory system was capable of making him conscious of only five notes, each one in a different octave. What would he hear? Certainly not Beethoven's fifth symphony. So after all we are not conscious of very much of what goes on around, about, and within us. Still worse, what we are conscious of is entirely different than it is in actuality.

An interesting illustration of the limitations of the sense of sight

is that of comparing our visual act with the X-ray. The optic nerve is said to respond to frequencies ranging from 3900 to 7700 A.U. and the X-ray from 3 to 12 A.U. Let us assume that the optic nerve were to respond to the same octave as the X-ray. We would see skeletons instead of human beings as we now know them. Under such circumstances it would be somewhat embarrassing to attempt to pass between two fat ladies of the circus.

I have chosen to touch upon some of these fundamental principles, not because you not already know them, but because few of us ever give them any serious consideration. We have become so accustomed to think in terms of nerves and neural pathways, muscular action and reaction, glands and their functions, circulation of blood, etc., that we hardly ever think of them as being merely different arrangements of the same thing, vibratory energy.

During the past few years there has been injected into optometric philosophy the idea that the universally accepted principle that hyperopia, myopia, and astigmatism are due primarily to anatomical imperfections is incorrect, and must be relegated to the scrap heap at once if optometry is to be recognized as a profession or is ever to become scientific. Since the primary purpose of the eyeball is evidently that of focussing light, and every optical instrument that has ever been constructed for that same purpose had to be so made that the refracting surfaces corresponded to the axial length, we pause to wonder wherein does the eyeball differ? Since the eyeball has all of the characteristics of man made optical instruments, and if light is not affected by it in the same way, then why is it made that way? We are asked to discard the term refractive error, and put in its place such terms as conditioned reflex and other new terms. By refractive error we have always understood an improper relationship between refracting surfaces and axial length. We are told that upon removal of eyes from their orbits, such improper relationships are rarely found. We do know, however, that there are considerable differences in corneas of different eyes, and also the chemistry or indexes vary to some degree according to the diet, amount of exercise and other conditions which affect the body metabolism. It would seem that to set an arbitrary standard to fit a theory is fallacious, but to discover a standard set by nature would be finding the truth.

Apparently in both the "refractive error" and the "conditioned reflex" theories, an arbitrary standard has been set, and evidently both are wrong. However, it might be safe to state that the old and new may be combined, and then if we add thereto the changes brought about by faulty metabolism, excessive near work, pathologic and functional disturbances in other parts of the body, improper optical corrections, and wrong mental habits we would perhaps arrive at a more nearly correct conclusion as to the cause of the various types of ocular discomfort.

The question has been asked, "why does an hyperopic eye show a with motion after it has been put in focus by accommodation?" It is

argued that when a skematic eye is adjusted to produce one diopter of hyperopia there is a with motion in the reflex, but when it is put in focus the reflex becomes neutral because the proper relationship between the refracting surface and axial length has been established, since however, the same phenomenon does not occur in the eye, the manifest hyperopia cannot be due to a "refractive error" or improper relationship between refractive surfaces and axial length. If we take for granted that the eye is achromatic, then difference in reflexes between the skematic eye and living eye might be considered as conclusive evidence that "refractive errors" due to anatomical imperfections are quite rare, but the more recent investigations of the focussing mechanism of the eye tend to show that the eye is not achromatic. There seems to be sufficient evidence to show that the eye does not focus all frequencies of the visible spectrum on the retina simultaneously. If that is correct, then we have a satisfactory explanation as.to why an hyperopic eye shows a with motion when put in focus by the crystalline lens, and does not rule out the fact that there may be an improper relationship between corneal curve and axial length. Of course, optometric investigators and educators are not the only ones who are guilty of setting an arbitrary standard to fit a theory. There is a long list of such transgression. The dentist will prove that infected teeth will cause almost all human ailments, the chiropractor will claim that if the spine is right there can't possibly be anything wrong with the body, the osteopath will show you that by stimulating the vagus nerve he can keep anyone fit indefinitely. The naturopath has no difficulty in keeping anybody in perfect health by administering mineral baths, colonic irrigation and the proper diet, while the general practitioner of medicine needs only to look at your tongue, take your temperature, write a prescription and then you can buy your health in any drugstore. All the surgeon needs to do is remove everything that is removable and then he too is happy, while the patient is quite often relieved of all discomfort forever. And last but by no means least, the psychiatrist needs but to psycho-analyze you by talking to you for about nine months, and then you're perfect.

According to physicists practically all of our observations are nothing but illusions anyway. As one of them puts it, "Our particular sense organs have given us a particular impression of this world. With different sense organs the world would be different to us. Take, for instance, the sense of sight. Suppose for a moment that you could see in the octave just below or just above the present light octave. None of the colors now visible would be sensed. If you used the octave below violet there would be no shadows. The sun would be seen as through a cloud or heavy fog and all parts of the sky would be equally luminous. Painting would be a very different art.

What is true of sight is equally true of other senses. The world is what it appears to be simply because our sense organs are what they are. They tell us nothing at all about what actually is. Solids, liquids and

gases would all be different to us if our sense organs were different, just as colors would be different if we used ultra-violet vision. If we can change our sense organs or change the sensitivity of them or increase their range of receptivity, then we shall have changed the world from our point of view. What this physical world really is, we cannot say, for we do not know what ether is and don't know how it is modified into electric charges and don't know the nature of the warps or strains in it in the regions of magnetism.

From the point of view of the majority the world is as described in the books. It is this way, perhaps, to all but one in a thousand or in a million, but that many people are usually wrong on fundamentals. Our sense impressions of what exists in actuality is about as reliable as the stories of jealous, devilish minded, rattling tongued, gossiping, scandal mongers of modern society.

Getting back to the probable causes of ocular discomfort it would seem logical to assume that the safest way would be to include all possible factors, and then analyze the case by the process of elimination until the least possible number of contributing factors are reached. Next, endeavor to determine which of the remaining factors are apt to be the greatest offenders, and begin eliminating them as rapidly as possible to alleviate the symptoms present.

In naming the probable causes of ocular discomfort we may have a long list. Optometrically, we would naturally begin with the forbidden term "refractive error" as the most frequent and most important factor. Next in their order we would probably find the following: unequal distribution of energy over the various nerve pathways, or what we used to call muscular imbalance.

Toxemia, abnormal psychology, functional disturbances in other parts of the body, emotional disturbances, etc. With the exception of high errors of ametropia, however, it is perhaps very seldom that any one factor alone will cause discomfort because the body will usually compensate for any one of them without much difficulty. So as optometrists, we must always remember that "the eye is a part of the body," and cannot be regarded as a separate entity.

We are told by those who have made a special study of the subject that the human body is a collection of some twenty-six trillion cells, and that there are about forty different kinds. That each type has a definite rate of vibration, and that when they all vibrate in harmony there is no discomfort, but when any of them are in some way disturbed or interfered with there is trouble. Any method that will restore harmony will relieve symptoms, and there are many such methods.

As optometrists we are too prone to think that our methods are the only correct ones. Let us not be too sure of ourselves. Let us keep ever alert to newer and better methods, investigate all methods used for the relief of ocular discomfort so that we may fully realize our position in

relation to other professions, and strive to be of greater benefit to our patients.

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ABSTRACTS

CATARACT. Neville Schuler. The Canadian Optometrist. Vol. 18, Numbers 1 and 2. 1936.

In cases of incipient senile cataract Schuler advises first a thorough physical examination by the patient's family physician; second, a complete ocular examination; third, the correction of all existing errors of refraction for both distance and near vision; fourth, the constant use of glasses for both distance and near vision, these being made up in a form of ophthalmic glass which will absorb as much of both the infra-red radiations and the ultra-violet radiations as possible and still give patients a fair degree of visual ability; fifth, advising patients to do as little near point work as possible and sixth to report back at frequent intervals to keep the corrections in as nearly correct form as possible as this seems to assist in retarding the development of the condition. While Schuler does not mention this, the reviewer has found the medium shade of Calobar ophthalmic glass to most nearly come up to his qualifications.

C. C. K.

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SPECTACLE SHORTAGE IN RUSSIA. Special Report. The Optician. Vol. XC, No. 2341, p. 454. 1936.

Several writers in the Soviet press have lately been calling attention to the extreme inadequacy of the supply of spectacles in their country. The shortage is particularly serious in the more easterly towns and in Siberia. In Swerdlowsk, for instance, a town of 500,000 people, there are no purely optical establishments although some chemists' shops possess "optical departments."

It is reported that two chemists' shops, with optical departments in Swerdlowsk are supplying some 9,000 pairs of glasses every month, but even this number is still far from meeting the demand. The position is similar in the whole of the Urals. In very few of the larger towns can spectacles be obtained, whilst in the countryside generally they are altogether non-existent.

The officials at the Health Administration at Swerdlowsk are continually receiving demands for spectacles, as well as many suggestions from factories, schools, and communal organizations, that trained optometrists should be sent round to examine all members requiring glasses.

Unfortunately, the actual production, as well as the distribution of glasses is deficient. For the most part they are prepared by hand, and the work is not systematically organized. The workshops are badly equipped, though they are often all too satisfied with the little equipment they have.

The would-be Russian spectacle wearer has, moreover, cause for dissatisfaction with the limited varieties of frame available. His requirements are generally simple enough, and he demands only solid, reasonably attractive frames at moderate price. Most of the metal frames are prepared in a factory in Witebsk, but numerous complaints are received from the public of the rough and clumsy work put into them. Celluloid frames are also being prepared in Witebsk. These are proving much more satisfactory but the quantity made is still unequal to the demand.

Before the War, Russia and Siberia were of course, supplied with their optical requirements chiefly from abroad, but following the war supplies have been cut off and for several years the optical requirements of the people had to be completely neglected. The Soviet regime has made some improvements, but the chances of the demand being completely satisfied are still remote. This is especially so since the Government seems as determined as ever to relieve the position by home manufacture rather than by improving the opportunities for foreign importers.

T. O. B.

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DINITROPHENOL CATARACT. Thomas G. Atkinson, M.D. The Optometric Weekly, Vol. 27, No. 1, page 7, 1936.

Atkinson claims that a new cause for cataract has recently come into the field, namely, a chemical substance taken, principally by women, for the purpose of reducing, and known as dinitrophenol. Unhappily, this drug is commonly prescribed by physicians, who either do not know, or who are skeptical of, its cataract producing effect. Atkinson has seen three cases of this condition within the past six months. Two of these were in his own practice and one in the practice of a colleague, in which he assisted in the extraction of the lens. All three of these cases were in relatively young women. His own two cases both being under thirty with no other ocular or systemic pathology being in evidence.

In his colleague's case, neither of them saw the cataract in the course of its progress. The cataractous lens was extremely swollen, making the anterior chamber so shallow as to offer some difficulty in transfixing and opening the cornea. On extraction, it proved to be a large, boggy, semi-solid mass, which could not be delivered all at once: one or two quite

large fragments had to be scooped out with a spoon. However, this, and irrigation of the chamber, succeeded in obtaining a clear, black pupil, and the patient obtained good post-operative vision. The other eye, at whose operation Atkinson also assisted a few weeks ago, showed similar manifestations.

His own two cases, both of which are within the last month, are in a comparatively early formative stage. Both, however, show the same characteristics. The lenses are noticeably swollen. The wort of the degenerative process is, for the present, in and around the nucleus, which appears to be softened and split. There are, however, several gray masses of opacity in the substance of the lens, not, apparently at the capsule borders, and these opacities also have the appearance, under the slit lamp, of being split. Vision is already very bad, and the progress of the cataract seems to be much more rapid than that of an ordinary cortical cataract, since it is less than a year that the patients stopped taking the drug.

Atkinson mentions these cases not because there is any particular difference in the relationship of dinitrophenol cataract to the optometrist from that of any other cataract, once it is established, but because as optometrists we have an opportunity to warn patients of the danger of taking dinitrophenol as a reducing agent. No matter what this or that man may think about the matter, there is, claims Atkinson, sufficient evidence in the authentic reports in literature, to make it fairly certain that the drug does cause cataract. And the fact that not everyone who takes the drug gets a cataract affords no insurance in individual cases.

C. C. K.

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STRABISMUS. Thomas Costa. Bulletin of the American College of Orthoptists. Paper No. 1, 1936.

Costa, in this short paper, stresses the need for a more intelligent application on the part of optometrists, of applied child psychology, in their juvenile cases in which the treatment of squint is attempted. He feels that the subject of instrumentation has been over-stressed in this field and that the important matter of properly handling the child has, in many cases been either ignored or overlooked.

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